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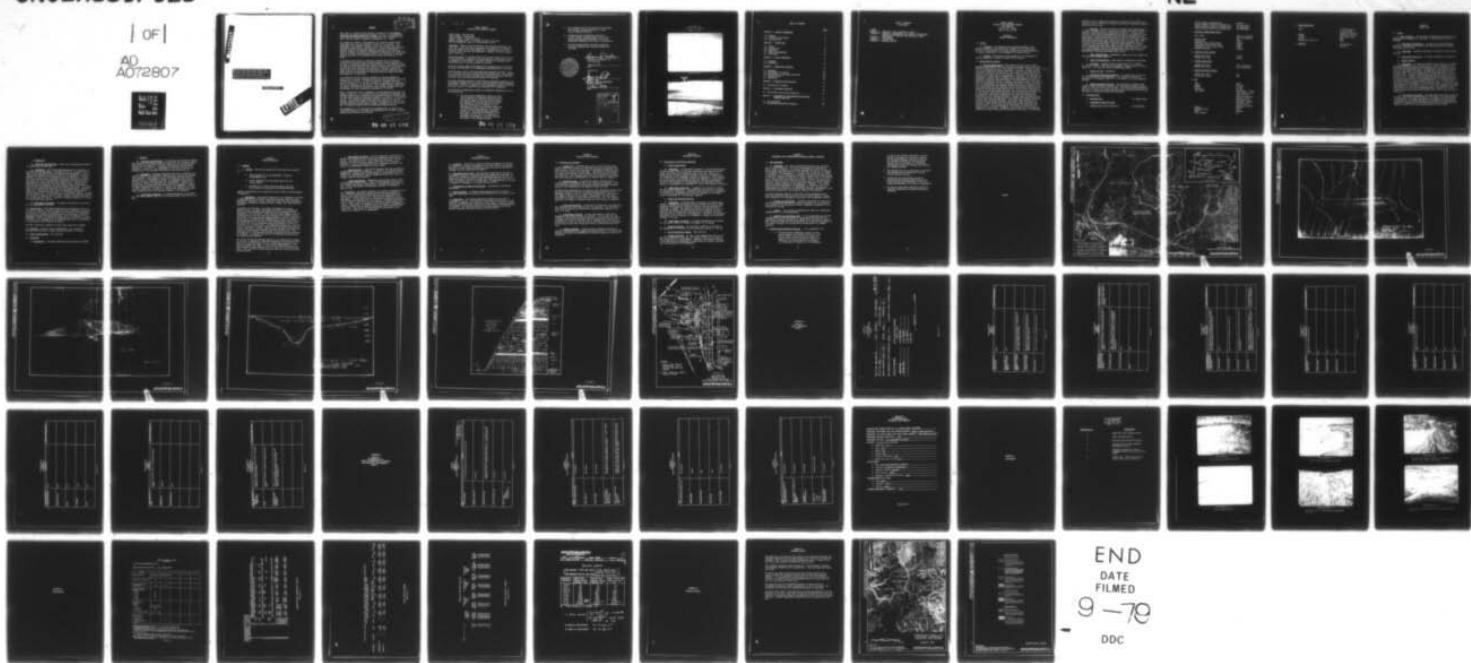
D'APPOLONIA CONSULTING ENGINEERS INC PITTSBURGH PA  
NATIONAL DAM INSPECTION PROGRAM. LAKE RENE DAM (LAKE RENE) (NDI--ETC(U))  
JUN 79

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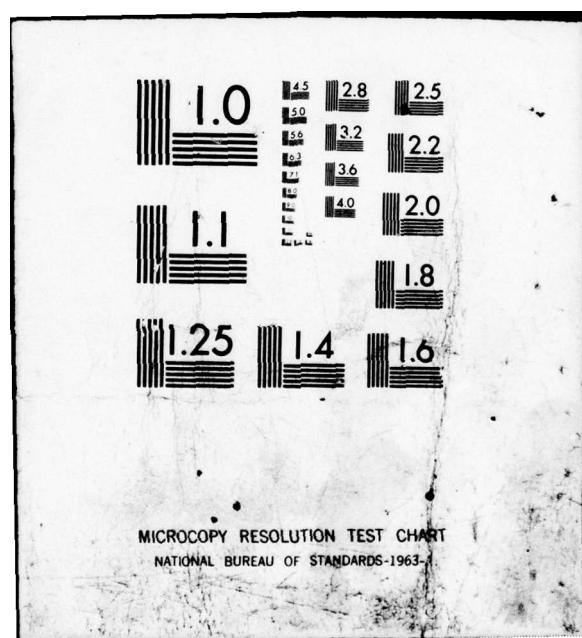
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National Dam Inspection Program. Lake  
Rene Dam (Lake Rene) (NDI PA-426, DER  
17-102), Ohio River Basin, Tributary of  
Narrows Creek, Clearfield County,  
Pennsylvania. Phase I Inspection Report.

DACW31-79-C-0014

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## PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Department of the Army, Office of Chief of Engineers, Washington, D.C. 20314.

The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon visual observations and review of available data. Detailed investigation and analyses involving topographic mapping, subsurface investigations, material testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the inspection is intended to identify any need for such studies which should be performed by the owner.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of the dam depends on numerous and constantly changing internal and external factors which are evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The assessment of the conditions and recommendations was made by the consulting engineer in accordance with generally and currently accepted engineering principles and practices.

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PAGE 1]

PHASE I REPORT  
NATIONAL DAM INSPECTION PROGRAM

NAME OF DAM: Lake Rene Dam  
STATE LOCATED: Pennsylvania  
COUNTY LOCATED: Clearfield County  
STREAM: Narrows Creek, a tributary of Sandy Lick Creek  
DATE OF INSPECTION: April 2, 1979 and May 4, 1979

ASSESSMENT: Based on the evaluation of the existing conditions, the condition of Lake Rene Dam is assessed to be unsafe due to numerous seeps and slumps on the downstream face of the dam and due to lack of operable outlet works for the reservoir. However, it is not an emergency condition.

The outlet works for the dam consist of an outlet conduit with no flow control mechanism. Reportedly, the upstream end of the outlet conduit is plugged by a steel plate. The outlet conduit is a series of oil drums placed end to end and encased in concrete.

There are numerous seeps and slumps on the downstream face of the dam starting from midheight of the embankment extending down to toe level.

Lake Rene Dam is one of the three dams which impound Lake Rene. There are no spillway structures associated with Lake Rene Dam. The spillways associated with the other two dams, Wolf Creek Dam and Galion Bay Dam, constitute the flood discharge facilities for Lake Rene.

The flood discharge capacity of Lake Rene was evaluated according to the recommended procedure and was found to pass 90 percent probable maximum flood (PMF); therefore, according to the recommended criteria, the flood discharge capacity of Lake Rene was classified to be inadequate.

The following recommendations should be implemented immediately or on a continuing basis:

1. The owner should immediately retain a professional engineer for detailed evaluation of the dam and the outlet structures and to prepare and execute plans for (a) controlling seepage and slumping on the downstream face of the dam, (b) evaluating the integrity of the embankment in view of the observed conditions, (c) evaluating the integrity of the outlet conduit, (d) providing emergency drawdown facilities. The detailed evaluation of the dam should include, but not be limited to, subsurface investigation, materials testing, and stability and seepage analyses.

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2. The upstream face of the dam should be provided with adequate erosion protection to avoid further shoreline erosion.
3. Around-the-clock surveillance should be provided during unusually heavy runoff and a formal warning system developed to alert the downstream residents in the event of emergencies.
4. The dam and appurtenant structures should be inspected regularly and necessary maintenance performed.



*Lawrence D. Andersen*

Lawrence D. Andersen, P.E.  
Vice President

June 25, 1979

Date

Approved by:

*James W. Peck*

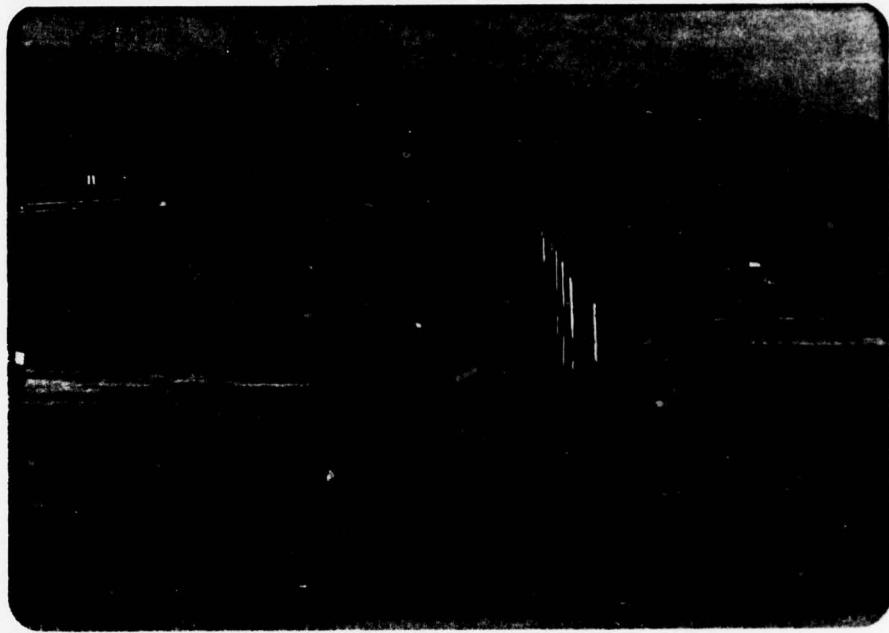
JAMES W. PECK  
Colonel, Corps of Engineers  
District Engineer

*27 June 1979*

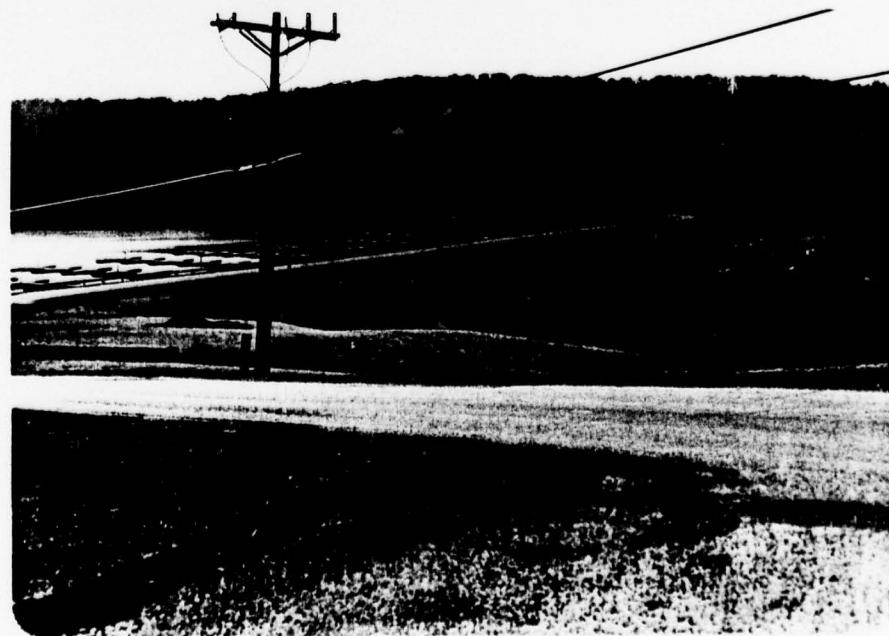
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LAKE RENE DAM  
NDI I.D. NO. PA-426  
APRIL 2, 1979



Upstream Face



Downstream Face

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PHASE I REPORT  
NATIONAL DAM INSPECTION PROGRAM  
LAKE RENE DAM  
NDI I.D. NO. PA-426  
DER I.D. NO. 17-102

SECTION 1  
PROJECT INFORMATION

1.1 General

a. Authority. The inspection was performed pursuant to the authority granted by The National Dam Inspection Act, Public Law 92-367, to the Secretary of the Army, through the Corps of Engineers, to conduct inspections of dams throughout the United States.

b. Purpose. The purpose of this inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project

a. Dam and Appurtenances. Lake Rene Dam consists of an earth embankment approximately 900 feet long with a maximum height of 82 feet from the downstream toe and a crest width of 60 feet. Lake Rene Dam is one of three dams which impound Lake Rene. The other two dams are Wolf Creek Dam, located at the west end of the reservoir, and Galion Bay Dam, located on the south side of the reservoir. Lake Rene Dam, which was constructed in 1955, was the original dam at the site. The original dam impounded a reservoir with a surface area of approximately 240 acres at normal pool elevation (Elevation 1658). The Wolf Creek and Galion Bay dams were constructed in 1971, increasing the surface area of the reservoir to approximately 310 acres at normal pool level of Elevation 1662.5. As it was constructed and presently exists, there are no spillway structures associated with Lake Rene Dam that would discharge flows from the reservoir into Narrows Creek below the dam. Prior to the construction of the Wolf Creek and Galion Bay dams, a natural saddle on the west side of the original Lake Rene diverted the flow from the Narrows Creek watershed into the Wolf Run watershed and constituted the spillway facilities for the original Lake Rene. Present flood discharge facilities for Lake Rene are comprised of the primary and emergency spillways at Wolf Creek and Galion Bay dams. The outlet works consist of oil barrels with the bottoms removed, placed end to end, and encased in concrete. There are no flow control facilities associated with this outlet conduit. The upstream end of this conduit is reported to be plugged by a steel plate. Allegedly, a chain which is long enough to reach to the shore of the lake is attached to this plate. The intended

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PAGE II]

procedure for the removal of this plate is pulling on this chain by a truck or a dozer. This outlet system constitutes the emergency drawdown facilities for the dam.

b. Location. The dam is located on Narrows Creek approximately 3-1/2 miles upstream from its confluence with Sandy Lick Creek in Sandy Township, Clearfield County, Pennsylvania (Plate 1). Narrows Creek follows a narrow valley downstream from the dam for approximately three miles where it flows under State Route 255 and Penn Central Railroad. Approximately 2000 feet downstream from the Route 255 underpass, Narrows Creek joins Sandy Lick Creek. Sandy Lick Creek, in turn, flows under Interstate Route 80 approximately one-half mile downstream from its confluence with Narrows Creek. There are approximately ten houses within the Narrows Creek valley about two miles downstream from the dam. It is estimated that failure of the dam would cause large loss of life and property damage, both in the Narrows Creek valley and in DuBois, approximately six miles downstream from the dam.

c. Size Classification. Intermediate (based on 82-foot height and 6750 acre-feet storage capacity).

d. Hazard Classification. High (based on downstream conditions).

e. Ownership. Treasure Lake of Pennsylvania, Inc. (address: Mr. James R. Farrer, Director of Development, Treasure Lake of Pennsylvania, Inc., P.O. Box 687, DuBois, Pennsylvania 15801).

f. Purpose of Dam. Recreation.

g. Design and Construction History. It appears that the dam was not formally designed and engineered. The dam was constructed by personnel of the original owner, Mr. J. E. DuBois, Jr., with completion in 1955.

h. Normal Operating Procedure. The reservoir is normally maintained at Elevation 1662.5, the level of uncontrolled primary spillway crests at Wolf Creek and Galion Bay dams. The inflow occurring when the lake is at or above the primary spillway levels of Wolf Creek and Galion Bay dams is discharged through these spillways.

### 1.3 Pertinent Data

a. <u>Drainage Area</u>	4.4 square miles
b. <u>Discharge at Dam Site (cfs)</u>	

Maximum known flood at dam site

Not applicable

Outlet conduit at maximum pool	Unknown
Gated spillway capacity at maximum pool	Not applicable
Ungated spillway capacity at maximum pool	Not applicable
Total spillway capacity at maximum pool	Not applicable

c. Elevation (USGS Datum) (feet)

Top of dam	1668 (as designed); 1674 (as measured)
Maximum pool	1670
Normal pool	1662.5
Upstream invert outlet works	Unknown
Downstream invert outlet works	1592+
Streambed at center line of dam	1590+
Maximum tailwater	Unknown

d. Reservoir Length (feet)

Normal pool level	10,000
Maximum pool level	10,000

e. Storage (acre-feet)

Normal pool level	3700 (estimated)
Maximum pool level	6750 (estimated)

f. Reservoir Surface (acres)

Normal pool level	310
Maximum pool level	360

g. Dam

Type	Earth
Length	900 feet
Height	82 feet
Top width	60 feet
Side slopes	Downstream: 1.3H:1V (top 15 feet of the dam); 2H:1V or flatter (remaining portion of the downstream slope; Upstream: 2.5H:1V (portion above normal pool level)
Zoning	Unknown
Impervious core	Yes
Cutoff	Unknown
Grout curtain	No

h. Regulating Outlet

Type	A conduit made up of oil barrels encased in concrete
Length	Reportedly 700 feet
Closure	Steel plate plug
Access	None
Regulating facilities	None

i. Spillway

The dam has no  
spillway

SECTION 2  
DESIGN DATA

2.1 Design

a. Data Available. The available information was provided by the Commonwealth of Pennsylvania, Department of Environmental Resources (PennDER).

(1) Hydrology and Hydraulics. The dam has no flood discharge facilities, therefore, there are no hydrology and hydraulic analyses associated with this dam.

(2) Embankment. Available information consists of several design sketches.

(3) Appurtenant Structures. No design information is available.

b. Design Features

(1) Embankment. As shown in a design sketch (Plate 2), the dam is a zoned embankment (Plate 3) consisting of a central impervious core with shale sections downstream and upstream and a rock-fill section at the toe of the downstream slope. The impervious core section is shown to be 24 feet wide at the base of the dam and 12 feet wide at about Elevation 1660. The same drawing shows the downstream face of the dam to have a 3H to 1V slope, while the upstream face was shown to have a slope 6H to 1V. However, field observations suggest that the dam was not constructed according to this design sketch. The downstream face of the dam was found to be much steeper than 3H to 1V. No evidence of a rock fill at the downstream toe of the dam was found. As it exists, the downstream face of the dam is 1.3H to 1V from crest elevation to a point approximately 15 feet below the crest, 2H to 1V for another 15 feet and 3H to 1V for the rest of the downstream slope. The portion of the upstream slope above normal pool elevation was found to have a slope of 2.5H to 1V.

(2) Appurtenant Structures. The appurtenant structures of the dam consist of an outlet conduit located at the center of the dam through the embankment. No design information is available for this conduit. As observed from the downstream end and as reported by the owner, the conduit was constructed of oil barrels placed end to end and encased in concrete. There are no flow control devices on this conduit.

c. Design Data

(1) Hydrology and Hydraulics. There are no hydrology and hydraulics design data for this dam.

(2) Embankment. Very limited engineering data are available on the design of the embankment. As shown on Plate 4, it appears that at least two borings were drilled for subsurface investigation. Plate 5 illustrates a geological profile for one of the abutments of the dam. However, the source of this information was not identified. A laboratory soils testing report prepared by Pittsburgh Testing Laboratory of Salt Lake City, Utah, indicates that laboratory soils tests included classification, compaction, and direct shear tests. The grain size distribution curve indicates that the material ranges from gravel to clay size with approximately 60 percent passing a 200 sieve. The liquid limit of the material was reported to be 32.5 percent with a plasticity index of 8. Direct shear tests were consolidated-undrained and the results were internal friction angle,  $\phi = 32$  degrees, cohesion,  $c = 0.05$  tons per square foot. As shown on Plate 2 and on other drawings included in the files, it appears that an attempt was made to analyze the stability of the slopes of the dam. However, no formal calculations or results of calculations were reported.

(3) Appurtenant Structures. No design calculations are available for the appurtenant structures.

2.2 Construction. Very limited information is available on the construction of the dam. Monthly inspection reports submitted by the owner to the state only refer to the amount of fill placed in the embankment. No reference to construction specifications or the manner in which the embankment material was placed was found. Prior to completion of the embankment in 1955, a new permit was obtained from the state to increase the height of the embankment by an additional five feet. No reference to final design crest elevation was found.

Available information indicates no major post-construction changes.

2.3 Operation. Treasure Lake of Pennsylvania, Inc., personnel reported that there are no formal operating records for this dam.

2.4 Other Investigations. None reported.

2.5 Evaluation

a. Availability. Available information was provided by PennDER.

b. Adequacy

(1) Hydrology and Hydraulics. No hydrology and hydraulic analyses were found for the original design for which flow over a natural saddle between Narrows Creek and Wolf Creek constituted the flood discharge facility for the reservoir. Hydrology and hydraulic analyses were performed in relation to the enlargement of Lake Rene in 1971 by the construction of two new dams, Wolf Creek Dam and Galion Bay Dam.

(2) Embankment. Although references were found to indicate very limited subsurface investigation, laboratory soil testing and analyses were performed. Data appear to be in preliminary form and were not incorporated in a comprehensive design. No references were found to indicate the type of material used for the embankment construction or the manner in which the embankment was constructed. A construction drawing shows an impervious core section for the embankment. However, no formal documents were found as to whether this impervious core was actually constructed. As shown in a construction drawing, the design lacks foundation cutoff and internal drainage of the embankment.

(3) Appurtenant Structures. No design information is available for the outlet conduit, which is the only appurtenant structure for the dam.

SECTION 3  
VISUAL INSPECTION

3.1 Findings

a. General. The on-site inspection of Lake Rene dam consisted of:

1. Visual inspection of the embankment, abutments, and embankment toe.
2. Visual examination of the downstream end of the outlet conduit.
3. Observation of factors affecting runoff potential for evaluation of downstream area hazard potential.

Specific observations are illustrated in Plate 6 and in the photographs in Appendix C.

b. Embankment. The general inspection of the embankment consisted of searching for indications of structural distress, such as cracks, subsidence, bulging, wet areas, seeps and boils, and observing general maintenance conditions, vegetative cover, erosion, and other surficial features.

In general, the condition of the dam is considered to be poor. Numerous seeps, wet areas, and slumps were found on the downstream face of the dam extending approximately from the midheight of the embankment to the toe level. Total flow from three seepages near the right abutment at the toe level was estimated to be about 5 gallons per minute. Flow from another seepage located on the left side of the outlet pipe was estimated to be approximately 10 gallons per minute. The downstream face of the dam is very irregular with varying slopes. The top 15 feet of the downstream slope was estimated to be on 1.3 horizontal to 1 vertical slope. The remaining portions are 2 horizontal to 1 vertical or flatter. While most of the downstream slope is covered with brush, a section near the right abutment is covered with trees up to four inches in diameter and 15 to 20 feet high. The upstream slope of the dam has no erosion protection and the shoreline is irregular. It appears that most of the shoreline irregularities are caused by wave erosion.

The top of the dam was surveyed relative to the normal pool elevation on the date of inspection, which was estimated to be Elevation 1662.5. Most of the crest was found to be at a level approximately 13 feet above the normal pool level. A low area was found adjacent to the left abutment and was measured to be 11.2 feet above the normal pool level. This is about 3.5 feet above the crests of the Wolf Creek and Galion Bay dams.

c. Appurtenant Structures. The only appurtenant structure of the dam is a concrete conduit through the embankment formed around oil barrels. The downstream end of the conduit was inspected. The oil barrels which form the outlet conduit were found to be seriously corroded. A flow of approximately one to two gallons per minute was found to be discharging through the outlet conduit.

d. Reservoir Area. A map review indicates that the watershed is predominantly covered by woodlands. A review of the regional geology (Appendix E) indicates that the shorelines of the reservoir are not likely to be susceptible to massive landslides which would affect the storage volume of the reservoir.

e. Downstream Channel. Downstream from the dam, Narrows Creek flows through a narrow valley. There are approximately 10 houses in the Narrows Creek valley, located about 1.5 miles downstream from the dam. Further description of downstream conditions is included in Section 1.2b.

3.2 Evaluation. The overall condition of the dam is considered to be poor. The most significant conditions noted were the presence of extensive wet areas and associated slumps on the downstream face of the dam which raised concern as to the continued stability of the embankment. The upstream slope of the dam has no erosion protection and is therefore susceptible to wave erosion. Although the dam has an outlet conduit, there is no means of controlling flow through this conduit. Reportedly, the upstream end of this conduit is plugged by a steel plate which can be removed by pulling a chain attached to the steel plate. This method of controlling flow through the outlet conduit is considered to be unacceptable.

SECTION 4  
OPERATIONAL FEATURES

4.1 Procedure. There are no formal operating procedures for the dam. The reservoir is normally maintained at the crest level of the primary spillways for Wolf Creek and Galion Bay dams, with excess inflow discharging over the uncontrolled spillways.

4.2 Maintenance of the Dam. The maintenance condition of the dam is considered to be poor. It appears that no attempts have been made to control the seepage and slumps on the downstream slope of the dam. The downstream face of the dam is covered with brush and trees up to four inches in diameter and 15 to 20 feet high. The upstream face of the dam is irregular and appears to be eroded by wave action.

4.3 Maintenance of Operating Facilities. The dam has no operating facilities.

4.4 Warning System. No formal warning system exists for the dam. Telephone communication facilities are available in the vicinity of the site.

4.5 Evaluation. The overall maintenance condition of the dam is considered to be poor. The dam has no functional outlet works. It is therefore recommended that either the outlet conduit should be equipped with upstream flow control facilities or other means of drawdown should be provided. The brush and trees on the downstream face of the dam should be removed and erosion ditches should be filled.

SECTION 5  
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features

a. Design Data. Lake Rene Dam is one of the three dams which impound Lake Rene. There are no spillway structures associated with Lake Rene Dam. Inflow into Lake Rene is discharged through the spillways of Wolf Creek and Galion Bay dams. Lake Rene has a watershed of 4.4 square miles and has a water surface area of 310 acres at normal pool elevation. The combined capacity of the spillways of Wolf Creek and Galion Bay dams is determined to be 5300 cfs with no freeboard.

b. Experience Data. As previously stated, Lake Rene Dam is classified as an intermediate dam in the high hazard category. Under the recommended criteria for evaluating emergency spillway discharge capacity, such impoundments are required to pass full PMF.

The PMF inflow hydrograph for the reservoir was determined utilizing the Dam Safety Version of the HEC-1 computer program developed by the Hydrologic Center of the U.S. Army, Corps of Engineers. Data used for the computer analyses are presented in Appendix D. The PMF inflow hydrograph was found to have a peak flow of 10,851 cfs. The computer input and the summary of computer output are also included in Appendix D.

c. Visual Observations. On the date of inspection, no conditions were observed that would indicate that the capacity of the spillways of Wolf Creek and Galion Bay dams would be significantly reduced in the event of a flood.

d. Overtopping Potential. Various percentages of PMF inflow hydrograph were routed through the reservoir. It was found that the spillways of Wolf Creek and Galion Bay dams can pass 100 percent PMF at a maximum pool level of Elevation 1670.3, leaving about 3-1/2 feet of freeboard to the low spot on the crest of Lake Rene Dam and overtopping the low spot on the crest (Elevation 1670.1) of Galion Bay Dam by 0.2 foot.

e. Spillway Adequacy. Since the flood discharge facilities of Lake Rene cannot pass the recommended spillway design of 100 percent PMF without overtopping the embankment, the spillway capacity is rated to be inadequate.

## SECTION 6 STRUCTURAL STABILITY

### 6.1 Evaluation of Structural Stability

#### a. Visual Observations

(1) Embankment. As discussed in Section 3, the field observations revealed various signs of distress consisting of extensive wet areas, seeps, and slumps on the downstream face of the dam. Because the design lacks a positive internal drainage system and the adequacy of the compaction of the embankment material is uncertain, concern exists as to the effect of the seepage through the embankment on the stability of the downstream slope and piping potential through the embankment. Therefore, the integrity of the embankment as an impounding structure should be investigated and reevaluated in view of the observed conditions.

(2) Appurtenant Structures. It appears that the outlet conduit was not formally engineered. No information was available to evaluate the adequacy of the design to withstand loads imposed by the embankment. It is therefore recommended that structural adequacy of the outlet conduit be assessed by a professional engineer.

#### b. Design and Construction Data

(1) Embankment. It appears that the dam was not formally engineered. Although references were found to indicate that very limited subsurface investigation, laboratory testing, and some analyses were conducted, it appears that these data were not incorporated into a comprehensive design. No reference was found to indicate the type of materials used for embankment construction and the manner in which this material was placed into the embankment. Therefore, the available information is not considered to be adequate to assess the structural adequacy of the dam.

(2) Appurtenant Structures. No design information is available for the outlet conduit to assess the adequacy of the design.

c. Operating Records. The structural stability of the dam is not considered to be affected by the operational features of the dam.

#### d. Post-Construction Changes. None reported.

e. Seismic Stability. In view of the concerns that exist as to the static stability of the dam, the seismic stability of the dam is also considered to be questionable. Therefore, the seismic stability of the dam should be reassessed in conjunction with further investigation and evaluation of the embankment.

SECTION 7  
ASSESSMENT AND RECOMMENDATIONS/PROPOSED REMEDIAL MEASURES

**7.1 Dam Assessment**

a. Assessment. The visual observations indicate that Lake Rene Dam is in poor condition. In view of the presence of numerous wet areas, seeps, and slumps on the downstream slope and due to the lack of any emergency drawdown facilities, the condition of the dam is assessed to be unsafe, but nonemergency. It appears that the dam was not formally engineered, and no information was found to document the construction of the dam. Although the dam has an outlet conduit, there is no positive way of controlling flow through this conduit. Further, in view of the manner in which the outlet conduit was constructed, oil drums encased in concrete, concern exists as to the structural integrity of the conduit under the imposed loadings of the embankment. Therefore, it is recommended that the condition of the embankment and outlet structure be investigated and evaluated by a professional engineer experienced in dam design and construction, and necessary remedial work performed.

The flood discharge capacity of Lake Rene via the spillways of Wolf Creek and Galion Bay dams was found to be 90 percent PMF and is therefore classified to be inadequate according to the recommended criteria.

b. Adequacy of Information. Available information in conjunction with visual observations and the previous experience of the inspectors are considered to be sufficient to make a reasonable assessment of the condition of the dam.

c. Urgency. The following recommendations should be implemented immediately or on a continuing basis.

d. Necessity for Additional Data. It is recommended that the dam and appurtenant structures should be investigated and evaluated by a professional engineer experienced in design and construction of dams to more accurately ascertain the consequences of the observed conditions on the overall integrity of the dam and to develop plans for remedial measures.

**7.2 Recommendations/Remedial Measures. It is recommended that:**

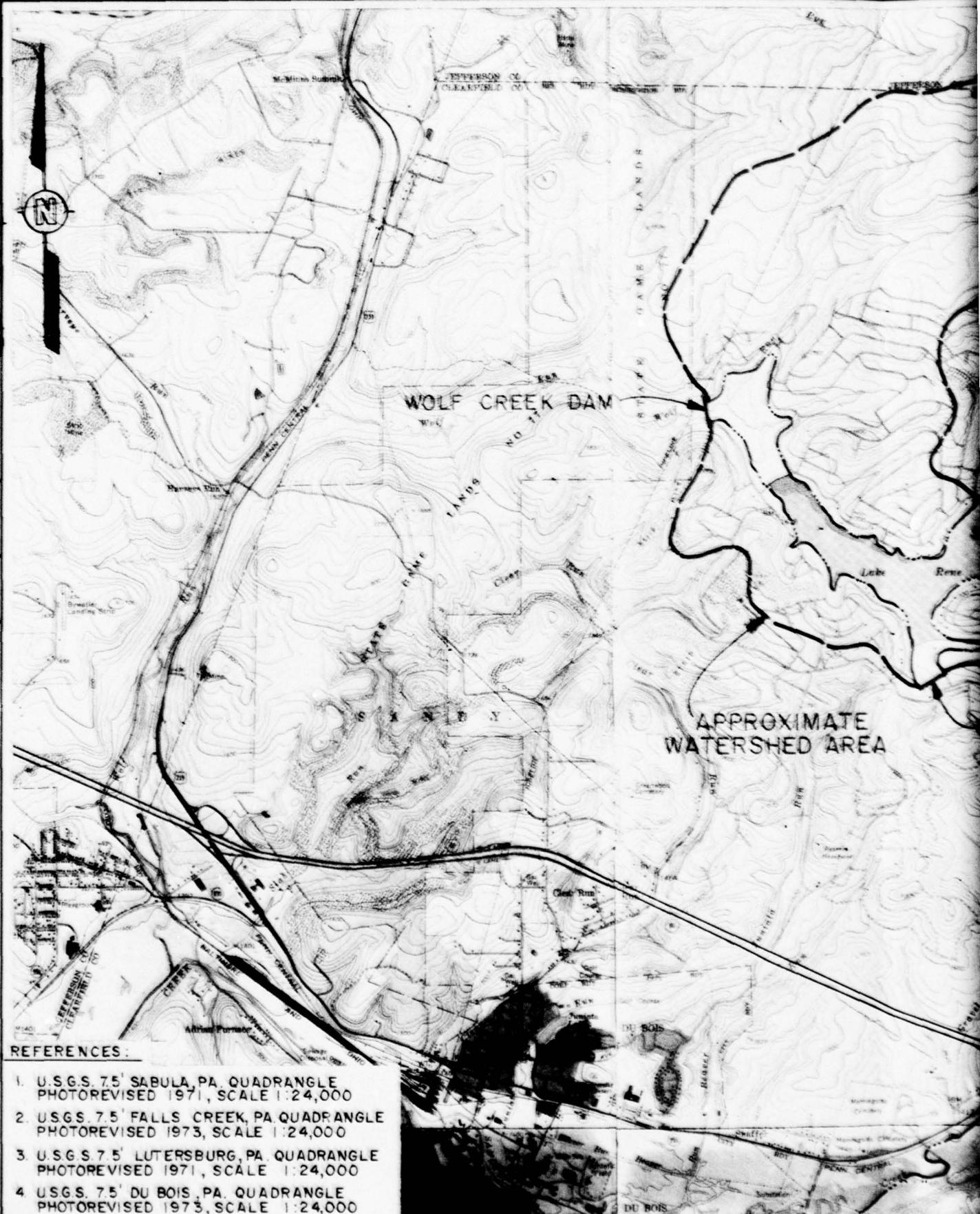
1. The owner should immediately retain a professional engineer for detailed evaluation of the dam and outlet structures and to prepare and execute plans for (a) controlling seepage and slumping on the downstream face of the dam, (b) evaluating the integrity of the embankment

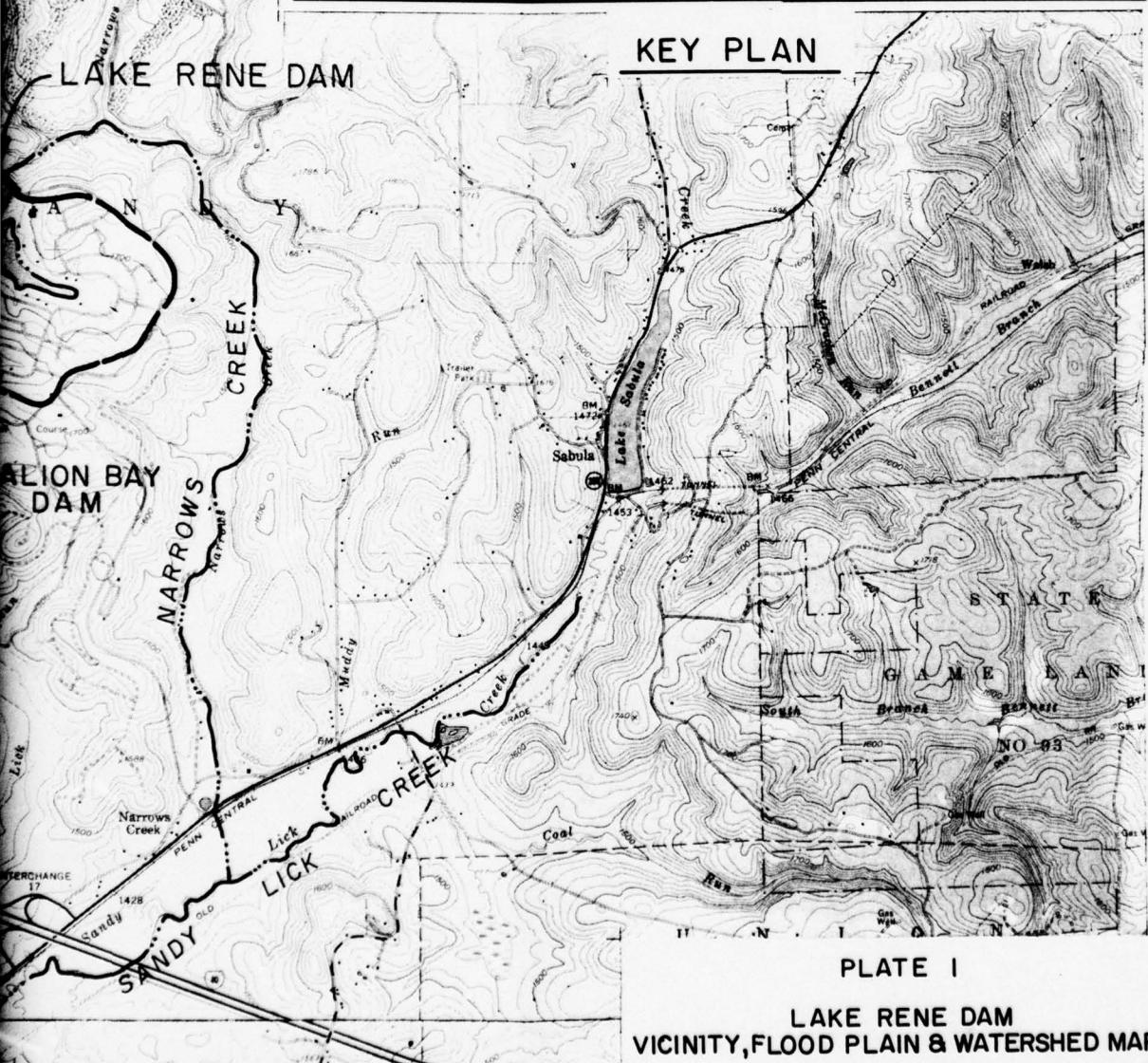
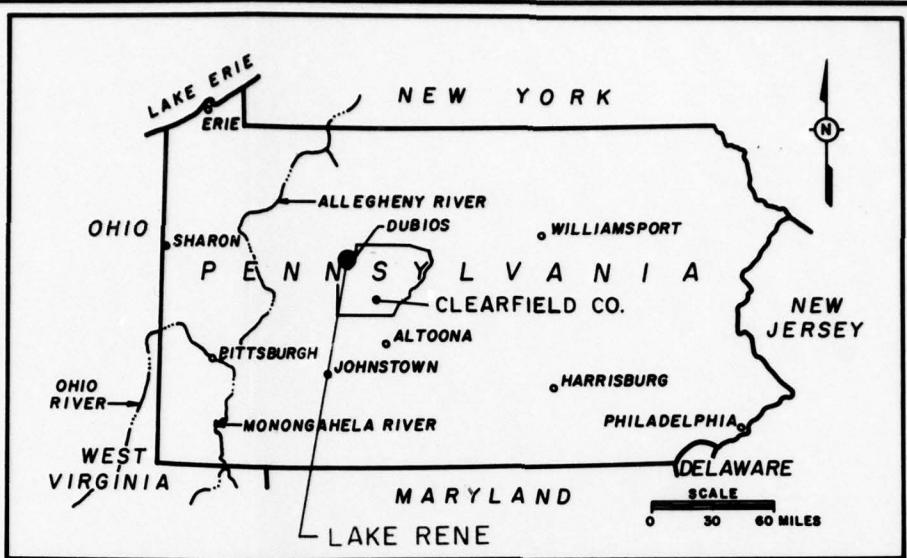
in view of the observed conditions, (c) evaluating the integrity of the outlet conduit, (d) providing emergency drawdown facilities. The detailed evaluation of the dam should include, but not be limited to, subsurface investigation, materials testing, and stability and seepage analyses.

2. The upstream face of the dam should be provided with adequate erosion protection to avoid further shoreline erosion.
3. Around-the-clock surveillance should be provided during unusually heavy runoff and a formal warning system developed to alert the downstream residents in the event of emergencies.
4. The dam and appurtenant structures should be inspected regularly and necessary maintenance performed.

**PLATES**

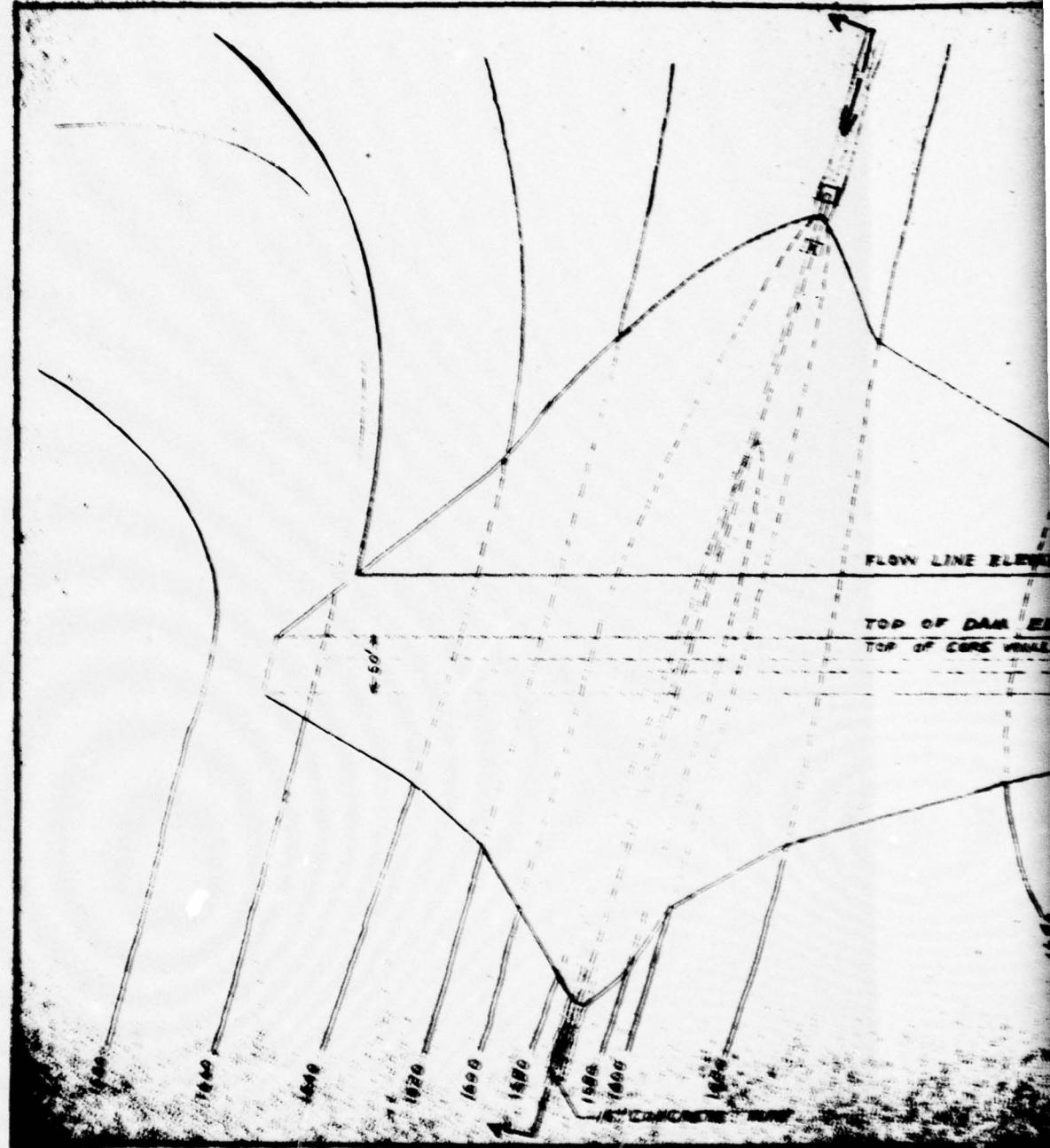
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**D'APPOLONIA**

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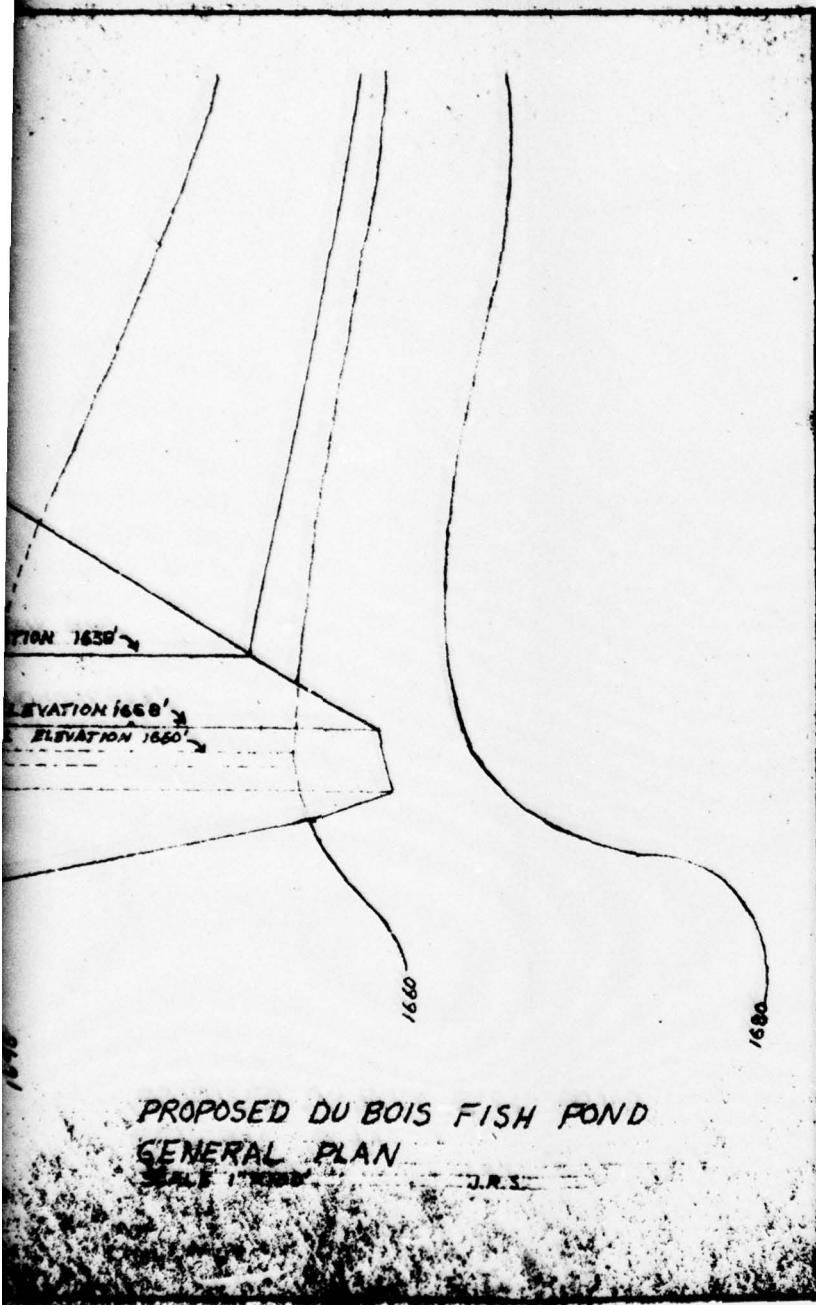
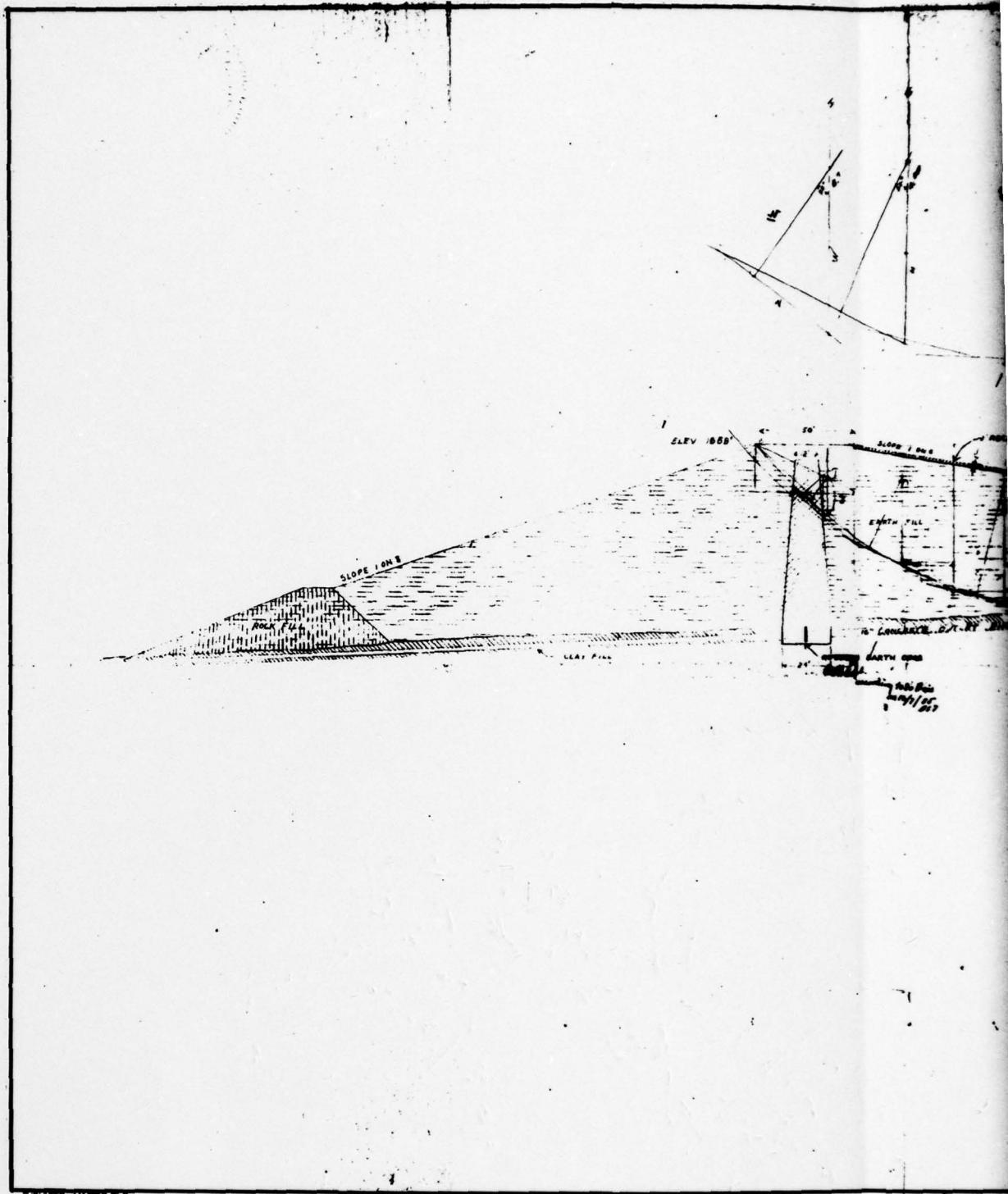
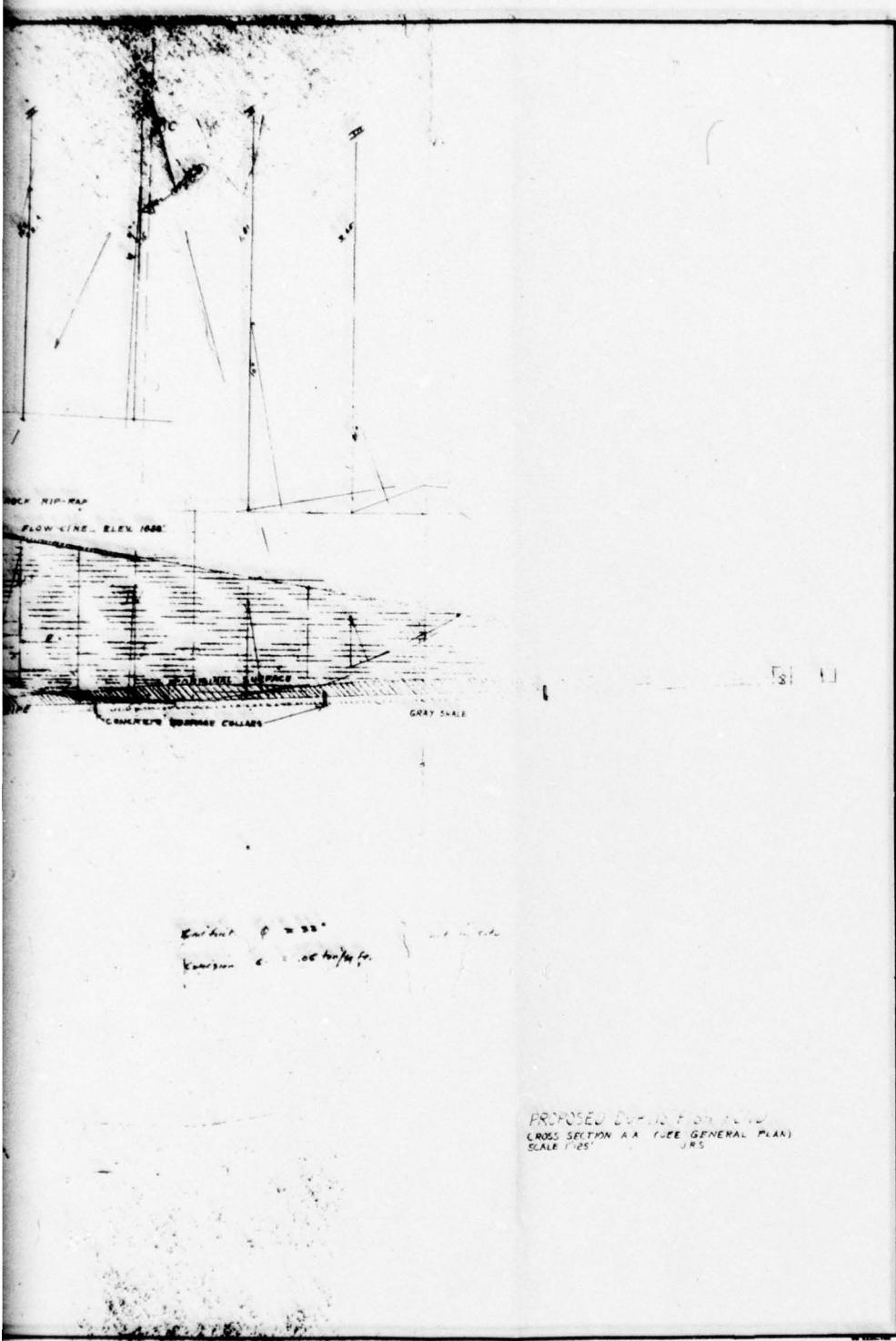


PLATE 2

D'APPOLONIA

DRAWN ACS CHECKED BY 6-9-77 DRAWING  
BY 5-22-79 APPROVED BY 6-3-77 NUMBER 78-367-B134



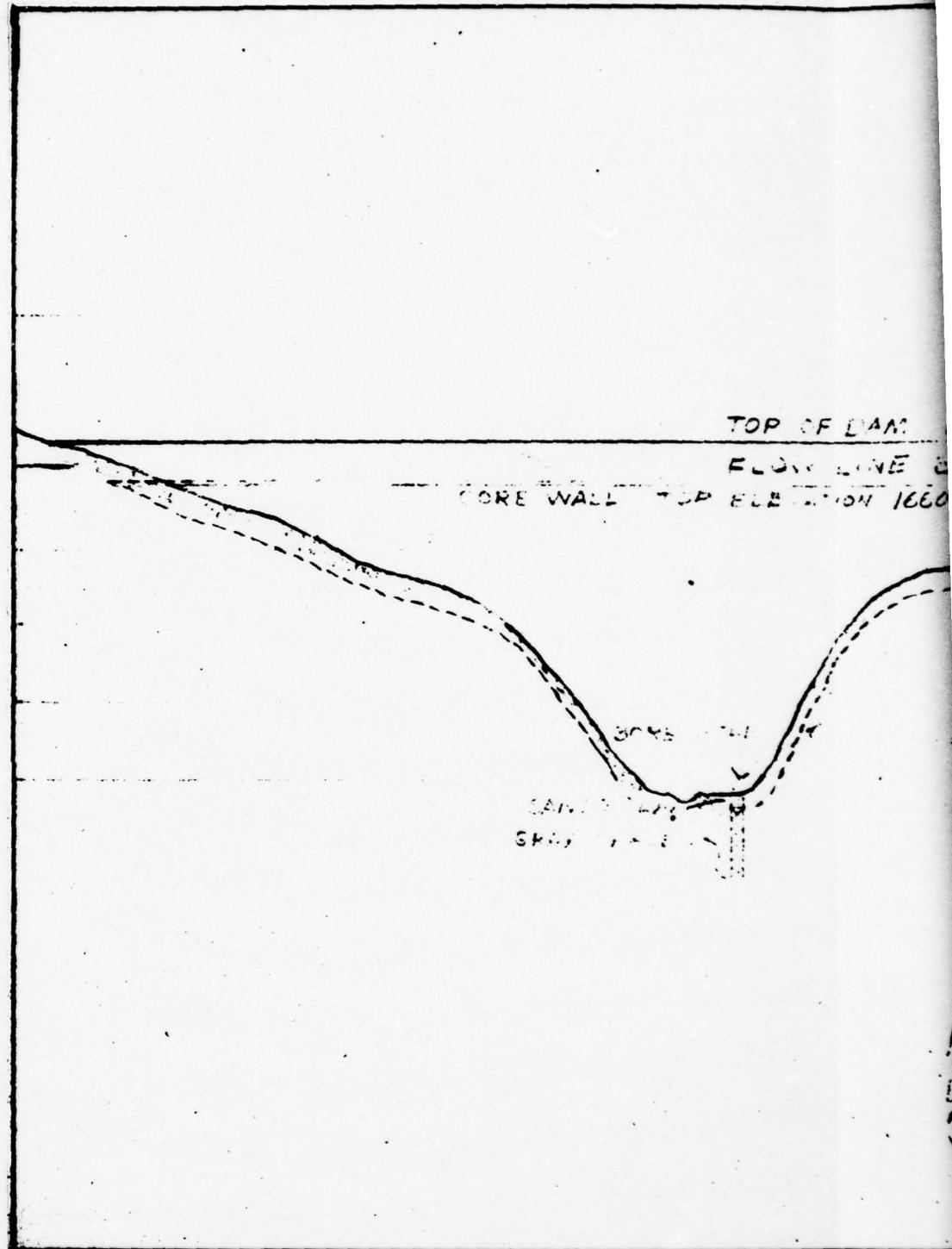


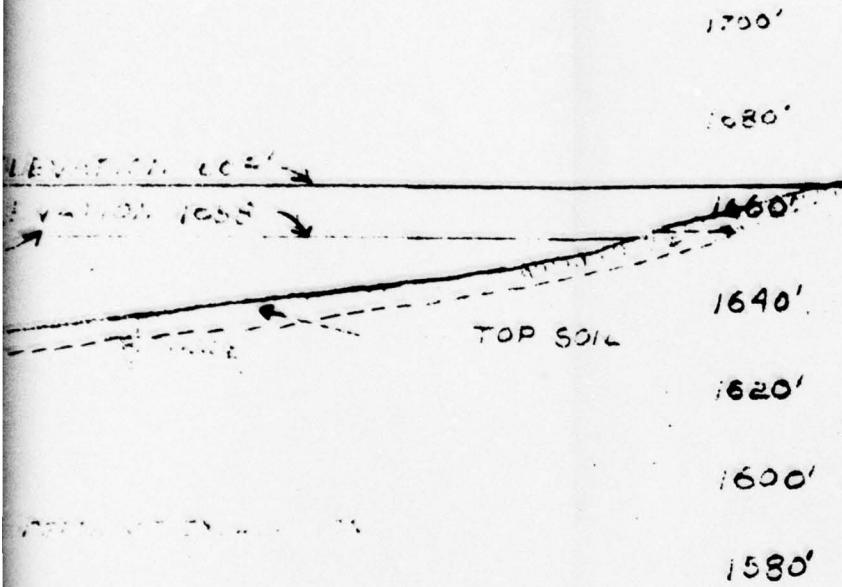
PROPOSED D'APPOLONIA  
CROSS SECTION AA (SEE GENERAL PLAN)  
SCALE 1/25"

PLATE 3

D'APPOLONIA

DRAWN BY	ACS	CHECKED BY	125	6-4-79	DRAWING NUMBER
			200	6.5.79	78-367-B-135
5-22-79	APPROVED BY				



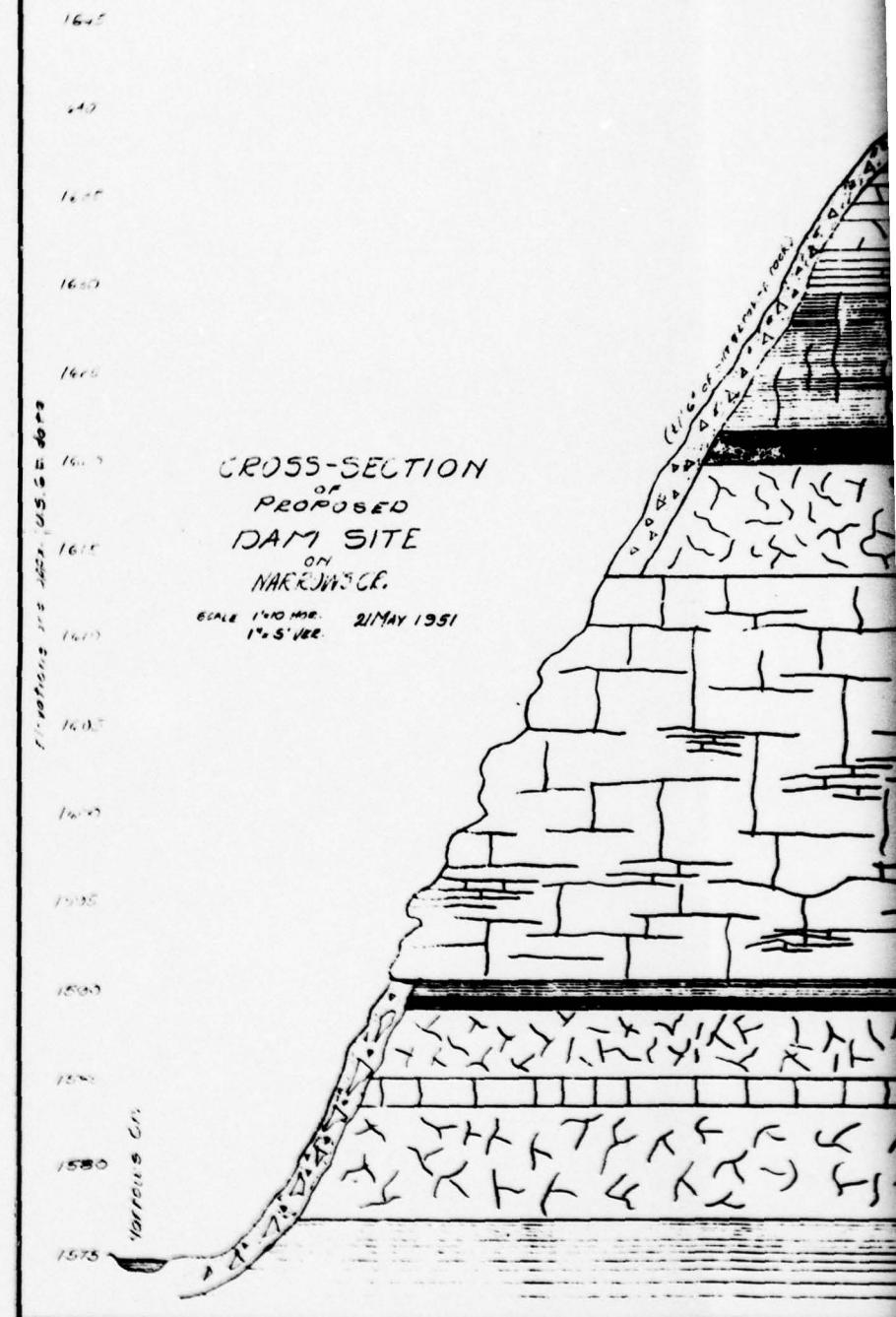


PROPOSED DU BIE FISH POND  
LONGITUDINAL SECTION  
HORIZONTAL SCALE 1"=100'  
VERTICAL SCALE 1"=40'  
J.R.S.

PLATE 4

D'APPOLONIA

DRAWN BY ACS 5-22-51 DRAWING NO. 6-4-22 NUMBER 78-367-B-136  
CHECKED BY A.S. APPROVED BY A.S.



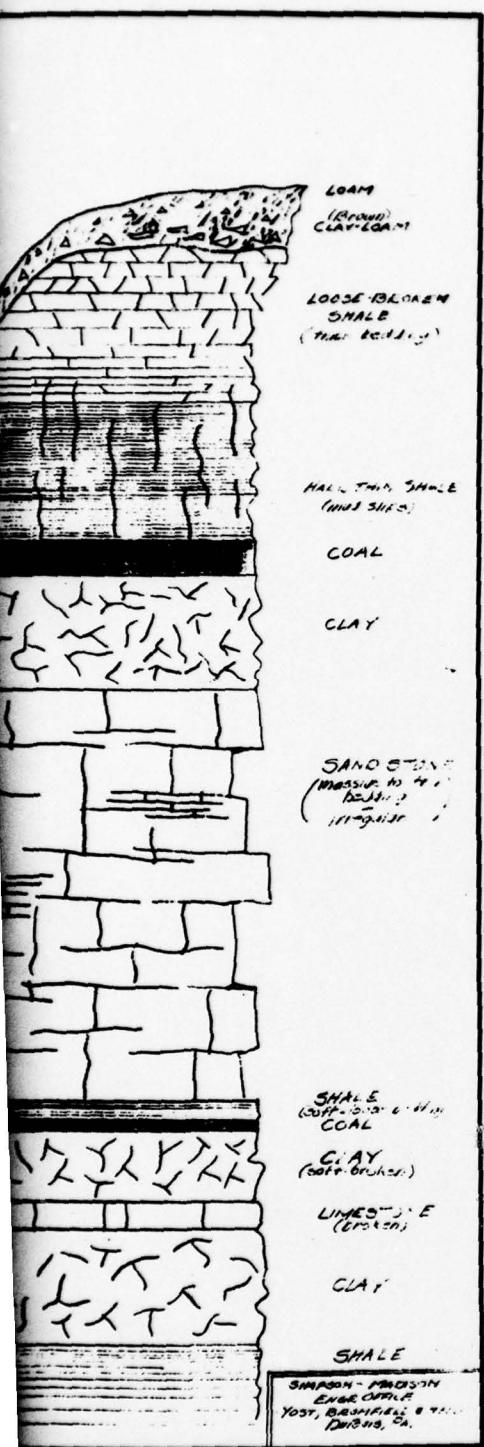


PLATE 5

D'APPOLONIA

DRAWN BY ACS CHECKED BY BE APPROVED BY SP 6-4-79 DRAWING NUMBER 78  
BY 5-7-79 6.5.79

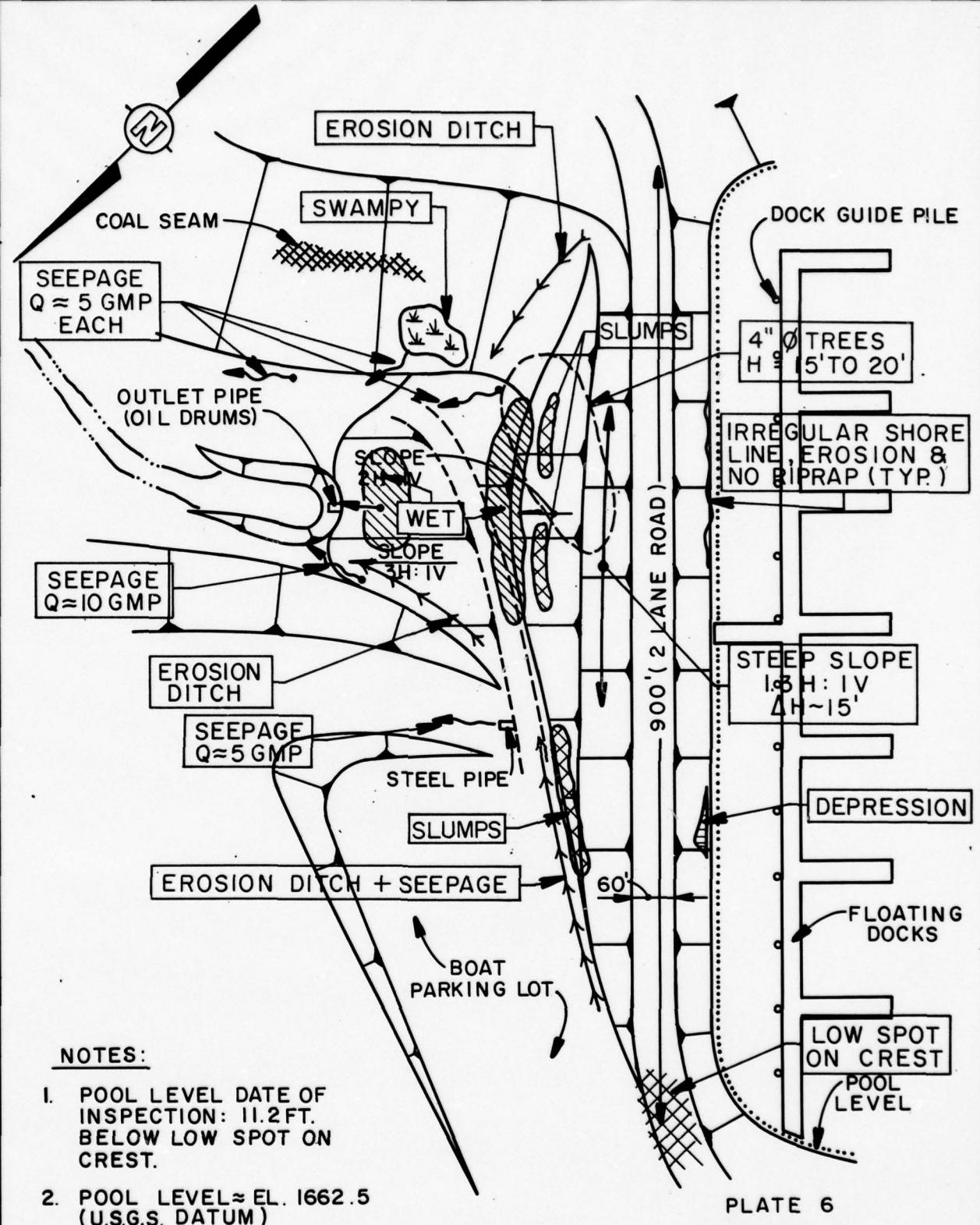


PLATE 6  
LAKE RENE DAM  
GENERAL PLAN  
FIELD INSPECTION NOTES  
FIELD INSPECTION DATE: APR. 2, 79

**D'APPOLONIA**

**APPENDIX A  
CHECKLIST  
VISUAL INSPECTION  
PHASE I**

APPENDIX A  
 CHECKLIST  
 VISUAL INSPECTION  
 PHASE I

NAME OF DAM	Lake Rene Dam	COUNTY	Clearfield	STATE	Pennsylvania	ID#	NDI I.D. PA-426 DER I.D. 17-102
TYPE OF DAM	Earth	HAZARD	CATEGORY	High			
DATE(S) INSPECTION	April 2, 1979	WEATHER	Sunny		TEMPERATURE	40s	
POOL ELEVATION AT TIME OF INSPECTION	1662.5	M.S.L.		TAILWATER AT TIME OF INSPECTION	1590±	M.S.L.	

INSPECTION PERSONNEL:

REVIEW INSPECTION PERSONNEL:

(May 4, 1979)

Bilgin Erel	E. D'Appolonia
Wah-Tak Chan	L. D. Andersen
	J. H. Poellot
Bilgin Erel	Billgin Erel

RECODER

**VISUAL INSPECTION  
PHASE 1  
ENBANKMENT**

<b>VISUAL EXAMINATION OF SURFACE CRACKS</b>	<b>OBSERVATIONS</b>	<b>REMARKS OR RECOMMENDATIONS</b>
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None.	
SLOUCHING OR EROSION OF ENBANKMENT AND ABUTMENT SLOPES	None.	There are at least three areas where the downstream face of the dam is slumping (see Plate 6). There are two major erosion ditches (see Plate 6).
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST		The lower spot on the crest is located near the left abutment at a level 11.2 feet above normal pool level (approximately Elevation 1662.5).
RIPRAP FAILURES		There is no riprap on the upstream slope of the dam.

## VISUAL INSPECTION

PHASE I

EMBANKMENT

VISUAL EXAMINATION OF JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
	A major erosion ditch at the junction of the right abutment. Erosion ditch and seepage at the junction with the left abutment.	The erosion ditches should be filled and seepage should be controlled.
ANY NOTICEABLE SEEPAGE	There are numerous seeps and wet areas on the downstream slope extending from the midheight of the embankment to toe level. See Plate 6 for location of wet areas and seepage points.	
STAFF GAGE AND RECORDER	None.	
DRAINS	None.	

VISUAL INSPECTION PHASE I OUTLET WORKS		REMARKS OR RECOMMENDATIONS
VISUAL EXAMINATION OF		
OBSERVATIONS		
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	The outlet conduit is not accessible. Only the downstream end is visible. The oil barrels around which the conduit was formed was observed to be seriously corroded.	
INTAKE STRUCTURE	None.	
OUTLET STRUCTURE	Outlet conduit with discharge into a plunge pool.	
OUTLET CHANNEL	No significant obstructions that would limit flow from the outlet conduit.	
EMERGENCY GATE	Allegedly, the upstream end of the outlet conduit is plugged by a steel plate which could be removed by pulling a chain which is attached to this plate. The operation of this plate was not observed.	The described means of controlling flow through the outlet conduit is unacceptable.

VISUAL INSPECTION  
PHASE I  
UNGATED SPILLWAY

		REMARKS OR RECOMMENDATIONS	
		OBSERVATIONS	
VISUAL EXAMINATION OF CONCRETE WEIR	(The dam has no spillway structures). N/A.		
APPROACH CHANNEL	N/A.		
DISCHARGE CHANNEL	N/A.		
BRIDGE AND PIERS	N/A.		

VISUAL INSPECTION PHASE I GATED SPILLWAY		OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VISUAL EXAMINATION OF CONCRETE STILL.	(The dam has no spillway structures). N/A.		
APPROACH CHANNEL	N/A.		
DISCHARGE CHANNEL	N/A.		
BRIDGE PIERS	N/A.		
GATES AND OPERATION EQUIPMENT	N/A.		

VISUAL INSPECTION  
PHASE I  
INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER	None.	

VISUAL INSPECTION PHASE I		REMARKS OR RECOMMENDATIONS
VISUAL EXAMINATION OF	OBSERVATIONS	
SLOPES	Gentle to moderately steep. No significant shoreline erosion.	
SEDIMENTATION	Unknown.	
UPSTREAM RESERVOIRS	None.	

VISUAL INSPECTION PHASE I DOWNSTREAM CHANNEL		
VISUAL EXAMINATION OF CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
OBSTRUCTIONS DEBRIS, ETC.	There are no obstructions that would affect the discharge capacity of the outlet conduit.	
SLOPES	No apparent instability (immediately downstream from the dam).	
APPROXIMATE NUMBER OF HOMES AND POPULATION	There are approximately 10 houses in the Narrows Creek valley about 1-1/2 miles downstream from the dam. Population: approximately 50.	

**APPENDIX B  
CHECKLIST  
ENGINEERING DATA  
DESIGN, CONSTRUCTION, OPERATION  
AND HYDROLOGIC AND HYDRAULIC  
PHASE I**

APPENDIX B		NAME OF DAM	Lake Rene Dam
CHECKLIST	ENGINEERING DATA		
DESIGN, CONSTRUCTION, OPERATION PHASE I	ID#	NDI I.D. PA-426	
		DER I.D. 17-102	
ITEM	REMARKS		
AS-BUILT DRAWINGS	The design drawings are available in the state files.		
REGIONAL VICINITY MAP	See Plate 1.		
CONSTRUCTION HISTORY	The dam was constructed by the original owner, Mr. J. D. DuBois, Jr., with completion in 1955. It appears that the dam was not formally engineered.		
TYPICAL SECTIONS OF DAM	See Plate 3.		
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	See Plate 3.		

**CHECKLIST**  
**ENGINEERING DATA**  
**DESIGN, CONSTRUCTION, OPERATION**  
**PHASE I**

ITEM	REMARKS
BATHYMETRIC/RESERVOIR RECORDS	Not available.
DESIGN REPORTS	None prepared.
GEOLGY REPORTS	None prepared.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Some preliminary stability analyses are included on the design drawings. No reference to any formal calculations was found.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	It appears that no formal subsurface investigation was conducted for the design. Some limited soils testing was performed by Pittsburgh Testing Laboratories, of Salt Lake City, Utah in 1954.

CHECKLIST  
ENGINEERING DATA  
DESIGN, CONSTRUCTION, OPERATION  
PHASE: I

ITEM	REMARKS
POST CONSTRUCTION SURVEYS OF DAM	None reported.
BORROW SOURCES	Unknown.
MONITORING SYSTEMS	None.
MODIFICATIONS	None.
HIGH POOL RECORDS	Not recorded.

**CHECKLIST**  
**ENGINEERING DATA**  
**DESIGN, CONSTRUCTION, OPERATION**  
**PHASE I**

ITEM	REMARKS
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None reported.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None reported.
Maintenance operation records	Not recorded.
SPILLWAY PLAN SECTIONS DETAILS	The dam has no spillway.
OPERATING EQUIPMENT PLANS AND DETAILS	Not available.

CHECKLIST  
ENGINEERING DATA  
HYDROLOGIC AND HYDRAULIC

DRAINAGE AREA CHARACTERISTICS: 4.4 square miles, woodlands

ELEVATION; TOP NORMAL POOL AND STORAGE CAPACITY: 1662.5 (3700 acre-feet)

ELEVATION; TOP FLOOD CONTROL POOL AND STORAGE CAPACITY: 1674 (6700 acre-feet)

ELEVATION; MAXIMUM DESIGN POOL: 1670

ELEVATION; TOP DAM: 1674 (measured low spot)

SPILLWAY: The dam has no spillway.

- a. Elevation N/A
- b. Type N/A
- c. Width N/A
- d. Length N/A
- e. Location Spillover N/A
- f. Number and Type of Gates N/A

OUTLET WORKS:

- a. Type Oil drums encased in concrete
- b. Location At center of embankment.
- c. Entrance Inverts Unknown
- d. Exit Inverts 1592+
- e. Emergency Draindown Facilities None

HYDROMETEOROLOGICAL GAGES:

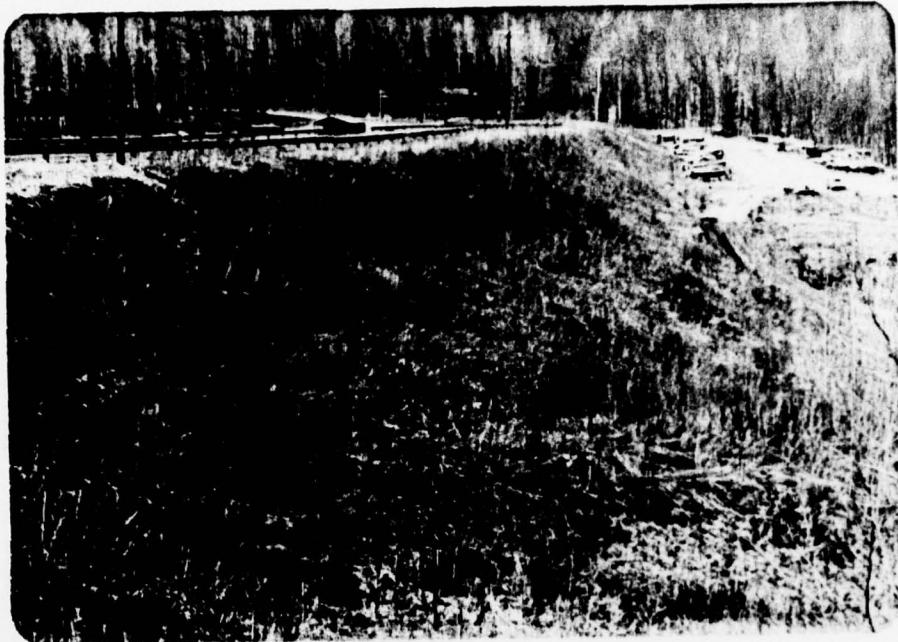
- a. Type None
- b. Location None
- c. Records None

MAXIMUM NONDAMAGING DISCHARGE: N/A

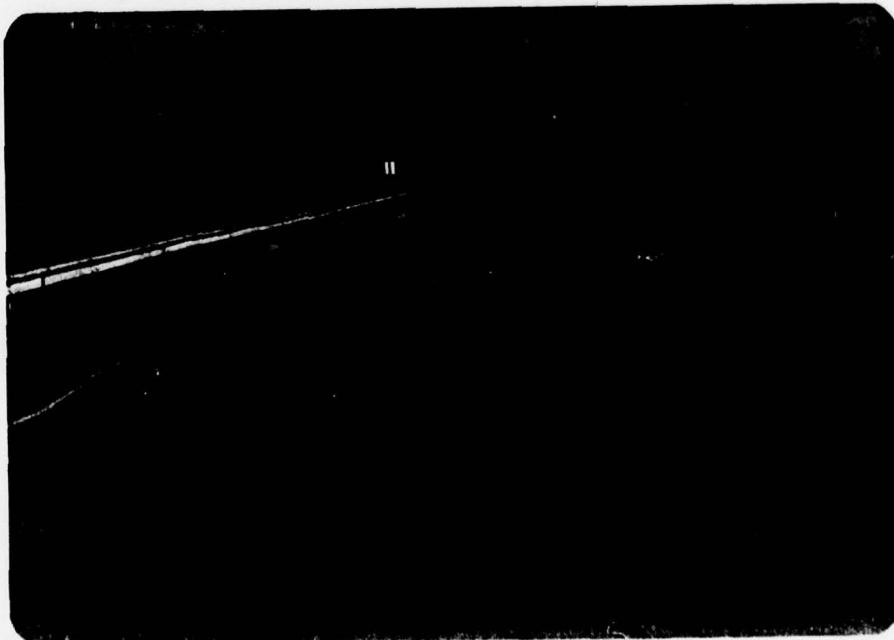
**APPENDIX C**  
**PHOTOGRAPHS**

LIST OF PHOTOGRAPHS  
LAKE RENE DAM  
NDI I.D. NO. PA-426  
APRIL 2, 1979

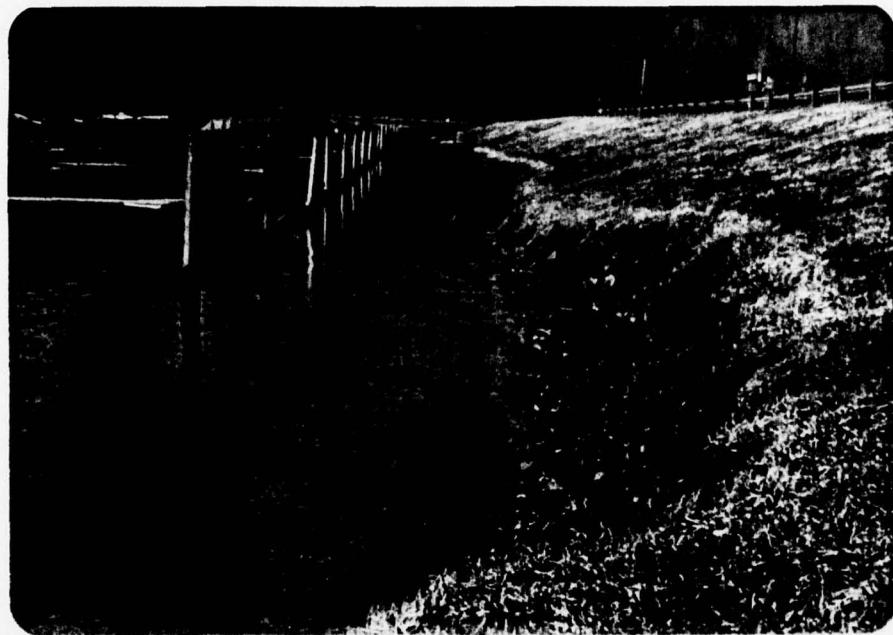
<u>PHOTOGRAPH NO.</u>	<u>DESCRIPTION</u>
1	Downstream face (looking north).
2	Crest (looking south).
3	Upstream slope shoreline erosion.
4	Erosion ditch at right abutment-embankment junction.
5	Seepage and slumps at center of embankment about 35 feet below crest level.
6	Outlet pipe. (Outlet pipe has no intake structure or controls.)



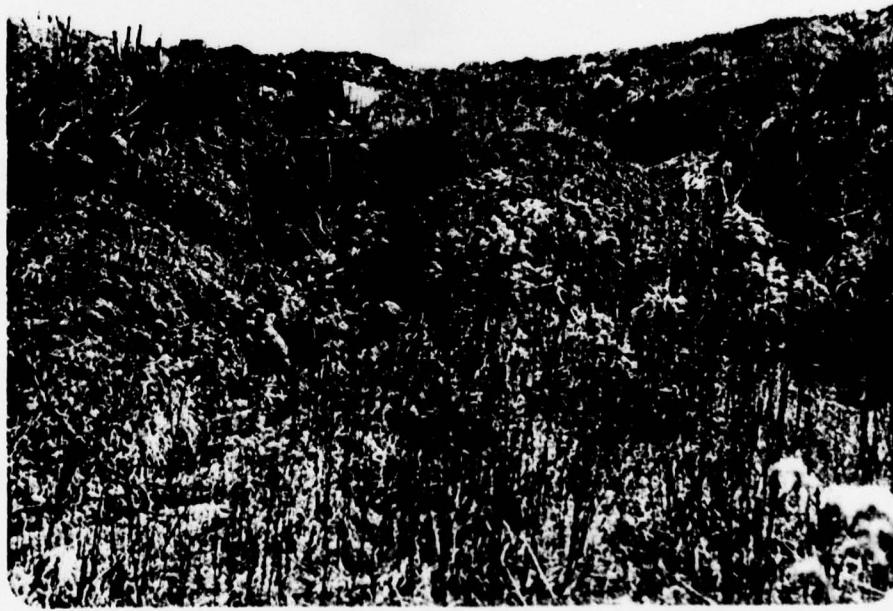
Photograph No. 1  
Downstream face (looking north).



Photograph No. 2  
Crest (looking south).



Photograph No. 3  
Upstream slope shoreline erosion.



Photograph No. 4  
Erosion ditch at right abutment-embankment  
junction.



Photograph No. 5

Seepage and slumps at center of embankment  
about 35 feet below crest level.



Photograph No. 6

Outlet pipe. (Outlet pipe has no intake structure  
or controls.)

**APPENDIX D**  
**CALCULATIONS**

HYDROLOGY AND HYDRAULIC ANALYSIS  
DATA BASE

NAME OF DAM: Lake Rene Dam (NDI I.D. PA-426)

PROBABLE MAXIMUM PRECIPITATION (PMP) = 23.3 INCHES/24 HOURS<sup>(1)</sup>

STATION	1	2	3	4	5
Station Description	Treasure Lake	Lake Rene Dam			
Drainage Area (square miles)	4.36	0			
Cumulative Drainage Area (square miles)	4.36	4.36			
Adjustment of PMF for Drainage Area (%)					
6 Hours	117	-			
12 Hours	127	-			
24 Hours	141	-			
48 Hours	151	-			
72 Hours	-	-			
Snyder Hydrograph Parameters					
Zone <sup>(3)</sup>	24	24A	-		
$C_p/C_t$ <sup>(4)</sup>	0.45/1.6	0.45/4.2	-		
L (miles) <sup>(5)</sup>	2.1	-			
$L_{ca}$ (miles) <sup>(5)</sup>	0.5	-			
$t_p = C_t(L \cdot L_{ca})^{0.3}$ (hours)	1.62	4.26	-		
Spillway Data <sup>(6)</sup>					
Crest Length (ft)	-	-			
Freeboard (ft)	-	11.3			
Discharge Coefficient	-	-			
Exponent	-	-			

(1) Hydrometeorological Report 33 (Figure 1), U.S. Army, Corps of Engineers, 1956.

(2) Hydrometeorological Report 33 (Figure 2), U.S. Army, Corps of Engineers, 1956.

(3) Hydrological zone defined by Corps of Engineers, Baltimore District, for determining Snyder's Coefficients ( $C_p$  and  $C_t$ ). Zone 24A was recommended by the COE. However, conservative Zone 24 was used.

(4) Snyder's Coefficients.

(5) L = Length of longest water course from outlet to basin divide.

$L_{ca}$  = Length of water course from outlet to point opposite the centroid of drainage area.

(6) Flood discharge capacity was based on the combined capacity of the primary and emergency spillways of Wolf Creek Dam and Galion Bay Dam.

FLOOD HYDROGRAPH PACKAGE (HEC-1)  
 DAM SAFETY VERSION      JULY 1978  
 LAST MODIFICATION    26 FEB 79

	SNYDER UNIT HYDROGRAPH, FLOOD ROUTING AND DAM OVERTOPPING ANALYSES					
1	TREASURE LAKE(LAKE RENE) CLEARYFIELD CO. ND 1-ID. PA426. PROJ. NO. 78-367-21					
2	FOR 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% AND 100% PMF					
3						
4	B	300	0	10	0	0
5	B1	5	1	1	0	0
6	J1	0.20	0.30	0.40	0.50	0.60
7	K0	1	1	1	1	1
8	CALCULATION OF SNYDER INFLOW HYDROGRAPH TO TREASURE LAKE(LAKE RENE DAM)					
9	K1	1	4.36	4.36	4.36	4.36
10	R	1	23.3	117	127	141
11	P	1	117	127	141	151
12	T	1	1.62	0.45	0.45	0.45
13	U	1	-1.0	-0.05	2.0	2.0
14	X	1	2	2	2	2
15	K1	1	ROUTING FLOW THROUGH DAMS AND SPILLWAYS OF TREASURE LAKE(LAKE RENE DAM)	1	1	1
16	Y	1	1	1	1	1
17	Y1	1	1663.0	1663.5	1664.6	1665.0
18	Y41662.5	1	1663.0	1663.5	1664.6	1665.2
19	Y5	0.0	40.0	112.0	248.0	512.0
20	SS1000.0	0	4052.0	4087.0	4087.0	4087.0
21	SE1662.5	1	1670.0	1675.0	1675.0	1675.0
22	SS1662.5	1	1670.0	1675.0	1675.0	1675.0
23	SD1670.1	3.1	1.5	2130.0	2130.0	2130.0
24	SL215.0	365.0	430.0	530.0	630.0	730.0
25	SV1670.1	1670.2	1670.4	1670.7	1670.8	1670.9
26	K99	99	99	99	99	99
27						

COMPUTER INPUT OVERTOPPING ANALYSIS

PAGE D2 of 4

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS  
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)  
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1	RATIO 2	RATIOS APPLIED TO FLOWS			RATIO 7	RATIO 8	RATIO 9
						RATIO 3	RATIO 4	RATIO 5			
						.20	.30	.40	.50	.60	.80
											1.00
HYDROGRAPH AT	1	( 11.29)	1	2170.	3255.	4340.	5425.	6510.	7596.	8681.	9766.
				( 61.45)	( 92.18)	( 122.90)	( 153.63)	( 184.36)	( 215.09)	( 245.81)	( 276.53)
ROUTED TO	2	( 11.29)	1	279.	628.	1273.	1917.	2553.	3387.	4180.	4954.
				( 7.91)	( 17.77)	( 36.06)	( 54.29)	( 72.28)	( 95.91)	( 118.36)	( 140.28)
											5913.
											167.43)

## SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1	ELEVATION STORAGE OUTFLOW	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM	TIME OF FAILURE		
					MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT
.20	1664.87	0.00	1963.	779.	0.00	48.83	0.00
.30	1665.88	0.00	2373.	628.	0.00	47.33	0.00
.40	1666.64	0.00	2683.	1273.	0.00	46.00	0.00
.50	1667.33	0.00	2966.	1917.	0.00	45.33	0.00
.60	1668.01	0.00	3243.	2553.	0.00	45.17	0.00
.70	1668.62	0.00	3489.	3387.	0.00	44.67	0.00
.80	1669.19	0.00	3723.	4180.	0.00	44.50	0.00
.90	1669.75	0.00	3951.	4954.	0.00	44.33	0.00
1.00	1670.27	.17	4163.	5913.	2.00	44.17	0.00

OVERTOPPING ANALYSIS SUMMARY

PAGE D4 of 4

**D'APPOLONIA**  
CONSULTING ENGINEERS, INC.

By NIC Date 4-18-79 Subject LAKE RENE Sheet No. 1 of 1  
 Chkd. By SE Date 4-19-79 SPILLWAY RATING Proj. No. 78-367-21  
22  
23

SPILLWAY RATING

TWO PRIMARY — 3' Ø PIPE W/ SCS RISER @ ELEV 1662.5 (1)  
 WOLF CREEK 130' @ 1665.2 (2)  
 TWO EMERGENCY ROCK CUT SPILLWAYS GALION BAY 26' @ 1664.6 (3)

ELEVATION. (ABOVE D/B)	WOLF CREEK COMBINED SPILLWAY CAPACITY, cfs	GALION BAY COMBINED SPILLWAY CAPACITY, cfs	TOTAL CAPACITY FOR TREASURE LAKE cfs
1662.5	0	0	0
1663	20	20	40
1663.5	56	56	112
1664.6	124	124	248
1665	138	137	295
1665.2	139	173	312
1666	3.92	294	686
1668	17.92	743	2535
1670	38.44 <small>TOP OF DAM</small>	1453	5297 ←
1675	109.33	4369	15302

NOTE: FIGURES ROUNDED UP TO NEAREST . cfs.

$$(1) \text{ PRIMARY SPILLWAYS} \left\{ \begin{array}{l} Q = 3.1(2L)H^{3/2} \quad L=9' \therefore Q = 55.8 \cdot H^{3/2} \\ \text{for } 0 < H < 1.5' \\ Q = C_s A_s \sqrt{2gH} \quad L_s = 207' \quad C_s \approx 0.8 \\ = 28.3 \cdot H^{1.5} \quad \text{for } H \geq 1 \end{array} \right.$$

$$(2) \text{ WOLF CR. EMER. SPILLWAY} \quad Q = 2.7(130) \cdot H^{1.5}$$

$$(3) \text{ GALION BY EMER. SPILLWAY} \quad Q = 2.7(26) \cdot H^{1.5}$$

**APPENDIX E**  
**REGIONAL GEOLOGY**

APPENDIX E  
REGIONAL GEOLOGY

Lake Rene Dam is located near the contact of the Allegheny Formation and Conemaugh Formation, both of Pennsylvanian Age. The site lies along the northwest flank of the Punxsutawney-Caledonia Syncline. Strata in the area dip to the southeast at about 100 feet per mile.

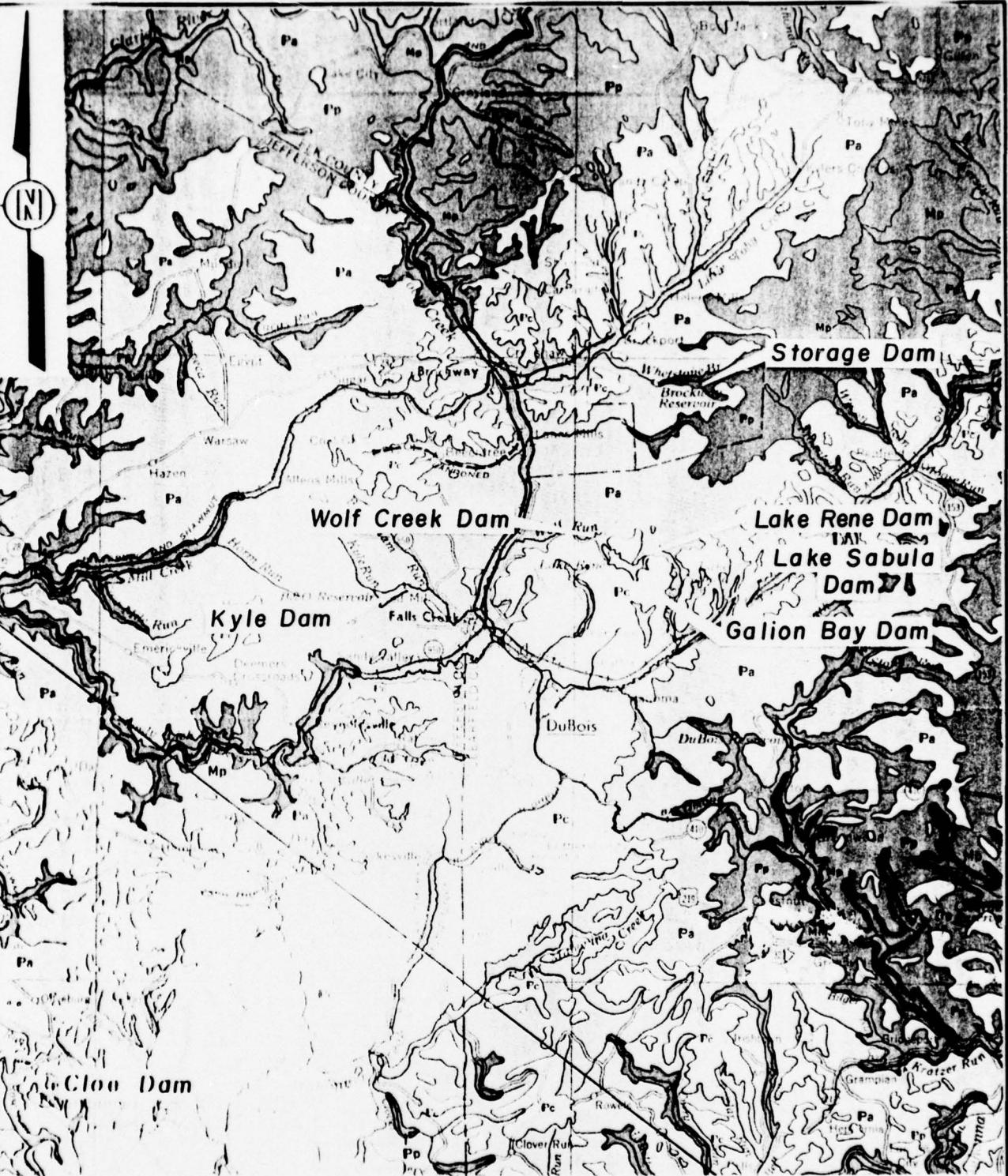
The Allegheny Formation consists primarily of thick-bedded to massive, coarse-grained sandstones and conglomerates. Thin coal seams and shales also exist.

The major coal seam in the area is the Upper Freeport which is the contact between the Allegheny Formation and the overlying Conemaugh Formation. This seam has been strip mined just west and northeast of the dam. The Lower Freeport and Kittanning coals also exist below the site and are potential coking coals.

The lower section of the Conemaugh Formation is characterized by interbedded sandstones, shales, claystones, and thin coal seams. The claystones are also known as redbeds and are prone to landslides.

One major fault exists in the area and is located approximately two miles northeast of the site. This fault is known as the Mountain Run Fault and trends to the northeast along the southeastern flank of the Boone Mountain Anticline. Maximum displacement along the fault is estimated to be 400 feet.

DRAWN BY ACS 5-29-79 DRAWING NUMBER 78 57-A34



STORAGE, WOLF CREEK, KYLE,  
LAKE RENE, LAKE SABULA,  
GALION BAY AND CLOE DAM

SCALE  
0 2 4 6 8 10 miles

GEOLOGY MAP

REFERENCE

GEOLOGIC MAP OF PENNSYLVANIA PREPARED  
BY COMMONWEALTH OF PENNA. DEPT. OF INTERNAL  
AFFAIRS, DATED 1960, SCALE 1: 4 MILES

PENNSYLVANIA

DRAWING 78 :7-A35  
6-4-79  
NUMBER 78  
DRAWING 78  
6-4-79  
APPROVED BY  
JFD  
6-4-79  
DRAWN ACS  
BY  
6-1-79

## PENNSYLVANIAN APPALACHIAN PLATEAU

**Pm**

### Monongahela Formation

Cyclic sequences of sandstone, shale, limestone and coal; limestone prominent in northern outcrop areas; shale and sandstone increase southward; commercial coals present; base at the bottom of the Pittsburgh Coal.

**Pc**

### Conemaugh Formation

Cyclic sequences of red and gray shales and siltstones with thin limestones and coals; massive Mahoning Sandstone commonly present at base; Ames Limestone present in middle of sections; Brush Creek Limestone in lower part of section.

**Po**

### Allegheny Group

Cyclic sequences of sandstone, shale, limestone and coal; numerous commercial coals; limestone thicker westward; Vanport Limestone in lower part of section; includes Freeport, Kittanning, and Clarion Formations.

**Pp**

### Pottsville Group

Predominantly sandstones and conglomerates with thin shales and coals; some coals mineable locally.

## ANTHRACITE REGION

**Pop**

### Post-Pottsville Formations

Brown or gray sandstones and shales with some conglomerate and numerous mineable coals.

**P**

### Pottsville Group

Light gray to white, coarse grained sandstones and conglomerates with some mineable coal; includes Sharp Mountain, Schuylkill, and Tumbling Run Formations.

## MISSISSIPPIAN

**Mmc**

### Mauch Chunk Formation

Red shales with brown to greenish gray flaggy sandstones; includes Greenbrier Limestone in Fayette, Westmoreland, and Somerset counties; Logatanna Limestone at the base in southwestern Pennsylvania.

**Pocono**

### Pocono Group

Predominantly gray, hard, massive, cross-bedded conglomerate and sandstone with some shale; includes in the Appalachian Plateau, Ricketts, Shenango, Canephora, Casselman, Cory, and Knapp Formations; includes part of "Oswayo" of M. L. Fuller in Potter and Tioga counties.

## GEOLOGY MAP LEGEND

### REFERENCE:

GEOLOGIC MAP OF PENNSYLVANIA PREPARED  
BY COMMONWEALTH OF PENNA. DEPT. OF INTERNAL  
AFFAIRS, DATED 1960, SCALE 1:4 MILES

D'APPOLONIA